

APPLICATION
Of
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For
UNITED STATES UTILITY PATENT
On
VEHICLE LEGAL COMPLIANCE SYSTEM

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TITLE: VEHICLE LEGAL COMPLIANCE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application for a utility patent claims the benefit of U.S. Provisional Application No. 60/391,126, filed June 24, 2002, incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

10 Not Applicable

BACKGROUND OF THE INVENTION

15 FIELD OF THE INVENTION:

This invention relates generally to vehicle compliance indicating devices, and more particularly to a vehicle legal compliance system that indicates the legal compliance status of a vehicle.

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DESCRIPTION OF RELATED ART:

Local, state, and national governments attempt to license, track, and otherwise monitor and control millions of vehicles, including automobiles and trucks. The vehicles are monitored
5 and controlled for purposes of revenue collection (vehicle registrations) and citation enforcement, for public safety reasons (regular vehicle inspections, use of vehicles in serious crimes and monitoring stolen vehicles), and for other policy reasons, such as maintaining a minimum level of insurance on the vehicle.

10 Several systems have been developed for the purposes of tracking vehicles. Adcox et al., U.S. 6,359,570 B1, teaches a vehicle status device and system for remotely updating and locally indicating the status of a vehicle. The vehicle status device is located in a vehicle and indicates status information for the vehicle on a vehicle-status indicator on the vehicle when the device is interrogated by an interrogating unit. The device includes a database of status
15 information for the vehicle and owner. An update receiver in the device receives encoded updated information from a wide area paging network for storage in the database. An interrogation receiver receives an interrogation signal from the interrogating unit, and a processor decodes the status information and sends it to the status indicator in response. The system also includes an interrogating unit which includes a police radar transmitter or a laser
20 transmitter for transmitting the interrogation signal to the vehicle status device. The status indicator includes a set of summary status lights and may also include an LCD display for detailed status information. In an alternative embodiment, the device uses a wireless Internet access device to access external databases and download the vehicle status information either

periodically or on demand. The information may be passed directly to the status indicator without the need for an internal database.

Hudson, U.S. 6,448,889 B1, teaches an apparatus attachable to a vehicle that can transmit the position of a vehicle to a telecommunications satellite or a telecommunications ground base station, and is particularly concerned with enabling authorities to police the vehicle with respect to its identity, location, theft and condition, as well as unlawful tampering of the apparatus. The apparatus may be in the configuration of a license plate.

Warner, U.S. 5,963,129, teaches a vehicle identification and information system for obtaining information on a plurality of vehicles. The system includes an identification unit, a remote unit, and a central microprocessor. The identification unit is installed in each vehicle and includes a first receiver for receiving information signals containing information regarding the vehicle from the central computer, a display device positioned on said vehicle for displaying information regarding the vehicle contained within the received information signal and an emergency signaling device for transmitting a distress signal to the receiver for display on the display device. The remote unit is positioned in a monitoring station and includes a transmitter for transmitting an information request signal to the central computer, a receiver for receiving an information response signal from the central computer, a microprocessor for processing the information response signal and a device for displaying the information received from the central computer. The central computer includes a database for storing the information regarding the plurality of vehicles and generates an information signal for transmission to both the identification unit and the remote unit.

The above-described references are hereby incorporated by reference in full.

The prior art teaches various vehicle identification and status indicating devices. However,
5 the prior art does not teach a status indication system that includes the benefits of the present system. The present invention fulfills these needs and provides further related advantages as described in the following summary.

SUMMARY OF THE INVENTION

The present invention teaches certain benefits in construction and use which give rise to the objectives described below.

15 The present invention provides a vehicle legal compliance system for reporting a compliance status of a vehicle. The vehicle legal compliance system has a central computer with a vehicle database, and a legal compliance indicator for indicating the legal compliance status of the vehicle. The vehicle database is adapted for storing a unique vehicle identifier associated with the vehicle, and the compliance status of the vehicle. The vehicle legal
20 compliance system also has a central processor for converting the unique vehicle identifier and the compliance status into a status indicator signal. The status indicator signal is received by the legal compliance indicator, and a microprocessor decodes the status indicator signal for operably controlling the status indicator. The legal compliance indicator is adapted

to be operably attached to the vehicle for displaying the status indicator and the results of the status indicator signal.

A primary objective of the present invention is to provide a vehicle legal compliance system
5 having advantages not taught by the prior art.

Another objective is to provide a vehicle legal compliance system in which a compliance status of a vehicle is stored on a central computer, and a status indicator signal is used to operably control a legal compliance indicator installed on or in the vehicle to visually display
10 the compliance status of the vehicle.

Another objective is to provide a vehicle legal compliance system that includes a status indicator for visibly displaying the compliance status of the vehicle.

15 Another objective is to provide computer system that includes external computers, such as a DMV computer, an insurance company computer, and a law enforcement computer, that are operatively integrated with the central computer via a computer network so that data in the external computers is automatically shared with the central computer and used to update the state of the legal compliance indicator.

20 Another objective is to provide a vehicle legal compliance system that reduces the costs of monitoring legal compliance of vehicles, and make it more difficult to commit fraud to avoid legal compliance.

A further objective is to provide a vehicle legal compliance system that enables the police or other person or system to quickly and easily identify and locate vehicles that are non-compliant, or that have been stolen, used to commit a crime, or are otherwise necessary to
5 locate.

Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawings illustrate the present invention. In such drawings:

FIGURE 1 is a block diagram of one embodiment of the present invention, a vehicle legal compliance system that utilizes a central computer to operably connect external computers for updating an legal compliance indicator that can be used to monitor one of a plurality of vehicles;

FIGURE 2A is a front elevational view of the legal compliance indicator of a vehicle that is legally compliant, showing first and second red/green LEDs both illuminated green.

FIGURE 2B is a front elevational view of the legal compliance indicator of a vehicle that has a registration that is due to expire in 30 days; showing the first red/green LED illuminated green and the second red/green LED illuminated red;

5 FIGURE 2C is a front elevational view of the legal compliance indicator of a vehicle that has a registration that has expired, showing the first and second red/green LEDs illuminated red;

FIGURE 2D is a front elevational view of the legal compliance indicator of a vehicle that
10 has a registration that is over 60 days past due, that has been reported stolen, was involved in an accident or kidnapping, has outstanding citations, or some other serious outstanding danger, infraction, or other problem, showing the first and second red/green LEDs flashing red;

15 FIGURE 3A is a front elevational view of a first embodiment of the legal compliance indicator, a license plate frame that includes a red LED and a green LED for, together, indicating the status of the vehicle being monitored;

FIGURE 3B is a front elevational view of a second embodiment of the legal compliance
20 indicator, an LED cluster that includes a pair of red LEDs and a pair of green LEDs mounted adjacent a resistor;

FIGURE 4 is a rear elevational view of a vehicle that includes a third embodiment of the legal compliance indicator that is mounted adjacent a third brake light of the vehicle;

FIGURE 5 is a block diagram illustrating a law enforcement vehicle responding to a red legal compliance indicator and retrieving information about the vehicle from the vehicle database of the central computer; and

FIGURE 6 is a flow diagram of the function of one embodiment of the vehicle legal compliance system.

DETAILED DESCRIPTION OF THE INVENTION

The above-described drawing figures illustrate the invention, a vehicle legal compliance system **10** for monitoring a plurality of vehicles **12**. For simplicity, in this discussion we will often refer to a single vehicle **12** rather than the plurality of vehicles **12**, with the understanding that the system is likely to be used to monitor many vehicles in the same manner in which it monitors the single vehicle **12**. The vehicle legal compliance system **10** can alert the owner of the vehicle **12**, police officers, or other parties that the vehicle **12** has not been registered, has been reported stolen, has been used in a kidnapping or other crime, or is being driven by a driver who does not carry insurance or has outstanding citations. The many uses and benefits of the present system **10** are described in greater detail below.

As shown in Fig. 1, the vehicle legal compliance system **10** utilizes a central computer **20** to operably connect external computers **40** for updating an legal compliance indicator **54** that can be used to monitor one of a plurality of vehicles **12**. The central computer **20** includes a vehicle database **22** that stores data associated with the vehicle **12**, including a unique vehicle
5 identifier **24** such as the VIN number of the vehicle or other unique identifier. The vehicle database **22** may also store an insurance status **26** of the vehicle **12**, a theft status **28** of the vehicle **12**, a DMV status **30** of the vehicle **12**. Each status could be listed as either compliant or non-compliant. In the alternative, more detailed information could also be included. For example, a registration deadline could be included in the DMV status **30** so
10 that a warning can be given the driver before the registration expires, as described below. The vehicle database **22** may also include additional useful information, such as an owner name **32**, an owner address **34**, and any other information that would be useful to track.

The central computer **20** includes a means for operably connecting **36** to a computer network
15 **38** such as the Internet or other network. In one embodiment, the means for operably connecting **36** is a modem connected to a high speed Internet connection such as a T1 connection. Such an Internet connection is well known in the art and is therefore not described in greater detail herein. Alternative and equivalent connections that can be devised by those skilled in the art should be considered within the scope of the invention.
20 Alternatives include a direct connection via telephone, wireless, satellite, or other means using proprietary software installed on the various computers. The central computer **20** may

be permanently connected to the computer network 38, or it may be limited to temporary connections established periodically for the update of information on the central computer 20.

Via the means for operatively connecting, the central computer 20 is connected to a plurality
5 of external computers 40 such as a law enforcement computer 42, an insurance company computer 44, a DMV computer 46, and/or other similar databases of useful information about the vehicle 12 and/or the driver. The central computer 20 includes a means for importing data 48 from the plurality of external computers 40 into the vehicle database 22 of the central computer 20. The means for importing data 48 is preferably a computer software program
10 that cooperates with software installed on each of the plurality of external computers 40 to periodically establish a link between the computers 20 and 40 and transmit the necessary data via the computer network 38. Since such software is known in the art, and can be implemented given the teachings of this invention, the software is not described in greater detail herein.

15 The central computer 20 is operable attached to a central transmitter/receiver 50 for establishing a wireless connection with any one of the plurality of legal compliance indicators 54 utilized by the vehicle legal compliance system 10. The wireless connection may be established through a satellite 52 to enable national or even global coverage of the vehicle
20 legal compliance system 10. In alternative embodiments, the wireless connection could be made through a wireless network such as cellular, Blue Tooth, RF, or other system known in the art or developed in the future.

While the vehicle legal compliance system **10** is anticipated to function with a plurality of legal compliance indicators **54**, potentially within the hundreds of millions of units, this application will discuss the function of a single legal compliance indicator **54** for purposes of clarity.

The legal compliance indicator **54** includes a vehicle transmitter/receiver **56** for receiving the communications from the central computer **20**. The vehicle transmitter/receiver **56** is operably attached to a microprocessor **58**, which is operably attached to a memory **60**, a power supply **62**, a status indicator **64**, and any additional electronic components that those skilled in the art would consider helpful in carrying out the function of the invention as described. The legal compliance indicator **54** may be powered by the vehicle **12**. In alternative embodiments, the legal compliance indicator **54** could be powered by a battery and/or solar cells operably connected to the legal compliance indicator **54**.

The memory **60** stores the unique vehicle identifier **24** that has been assigned to the vehicle **12** on which the legal compliance indicator **54** has been installed. The microprocessor **58** functions to recognize transmissions that are directed to the unique vehicle identifier **24** that is stored in the memory **60**, and to control the status of the status indicator **64** as directed by the central computer **20**.

In one embodiment, as shown in Figs. 2A-2D, the status indicator **64** includes first and second red/green LEDs **90** and **92**. When the vehicle **12** is legally compliant, as shown in Fig. 2A, the first and second red/green LEDs **90** and **92** are both green. If the vehicle registration is due to expire in 30 days, the second red/green LED **92** may turn red, as shown in Fig. 2B, thereby providing a warning to the driver without triggering a police response. As shown in Fig. 2C, if the vehicle's registration has expired, the first red/green LED **90** also turns red thereby alerting the police that the vehicle **12** is non-compliant. The police who see a non-compliant vehicle **12** can immediately spot the two red lights and pull the vehicle **12** over for a citation. The number of LEDs used, the colors of these LEDs, and the circumstances that lead to the various states of illumination of the LEDs can be varied by those skilled in the art, and alternative combinations of LEDs and LED lighting patterns should be considered within the scope of the invention as claimed below.

As shown in Fig. 2D, in the event that the vehicle **12** is involved in a serious infraction, or in any way poses a safety risk to the public, both the first and second red/green LEDs **90** and **92** turn red and flash. Examples of what would trigger such a response could include a report that the vehicle was stolen, if the vehicle was involved in an accident or kidnapping, and possibly also if the vehicle has outstanding citations or some other serious outstanding danger, infraction, or other problem.

In one embodiment, the first and second red/green LEDs **90** and **92** are illuminated at all times that the vehicle **12** is in use. In this embodiment, it is preferred that the legal

compliance indicator **54** include a motion sensor **93** (shown in Fig. 1) so that the first and second red/green LEDs **90** and **92** are only illuminated while the vehicle **12** is in use, and not when it is parked or otherwise inoperative. Those skilled in the art will recognize that the motion sensor **93** could alternatively include another equivalent sensor for sensing when the vehicle **12** is in use, such as when the ignition is turned on, and such alternative sensors should be included within the definition of the term motion sensor **93**.

In an alternative embodiment, the first and second red/green LEDs **90** and **92** are not always illuminated, but are only illuminated when the legal compliance indicator **54** is interrogated using a remote trigger **55**. The remote trigger may be a radar gun typically carried by the law enforcement vehicle **84**. In alternative embodiments, the remote trigger **55** may be a specialized electronic interrogator that uses a wave trigger such as RF, laser, or some other wireless trigger to activate the legal compliance indicator **54**. The structure and function of such a system can be devised by those skilled in the art, and is therefore not described in greater detail herein.

As shown in Fig. 3A, in another embodiment the status indicator **64** includes a pair of LEDs **66**, a green LED **68** and a red LED **70**, that are mounted on a license plate frame **72** of the vehicle **12**. The pair of LEDs **66** function to provide the following signals:

GREEN – When the green LED **68** is illuminated, the vehicle **12** is legally registered and in compliance with all state registration and insurance codes;

RED - When the red LED **70** is illuminated, the vehicle's **12** registration and or

insurance coverage has recently expired, or the owner of the vehicle **12** has an infraction on his or her record; and

FLASHING RED - When the red LED **70** is flashing, the vehicle's **12** has been reported as stolen, and/or the owner of the vehicle **12** is being sought by law enforcement. Of course, those skilled in the art can determine many factors that could be tracked and reported by the status indicator **64**, potentially including LEDs of other colors. It is important, however, that the status indicator **64** be simple and straightforward to clearly report simple status information.

In another embodiment the status indicator **64** may include an LED bulb **74** with multiple LEDs for brighter illumination and potentially a greater range of reporting capabilities. In one embodiment, as shown in Fig. 3B, the LED bulb **74** includes a housing **75** that includes a pair of red LEDs **76** and a pair of green LEDs **78** mounted around a resistor **80**. In this embodiment, the color of the LED bulb **74** is determined by which of the pair of LEDs **76** or **78** is illuminated. While the LED bulb **74** may include a pair of red LEDs **76** and a pair of green LEDs **78** to ensure that the LED bulb **74** is sufficiently bright, it is possible that the LED bulb **74** could include only a single red LED and a single green LED, or several red LEDs and several green LEDs, depending upon the brightness of the LEDs and the requirements of the status indicator **64**.

The LED bulb **74** may be mounted upon a carrier card **81** that includes a pair of suction cups **82**. The carrier card **81** may be adapted to be mounted in the rear window of the vehicle **12**

using the pair of suction cups **82**. While the pair of suction cups **82** is used in one embodiment, other means for mounting the carrier card **81** in the rear window, or side window, could also be used, including adhesive tape, hooks and loops (VELCRO®), or any other equivalent mounting means.

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As shown in Fig. 4, the legal compliance indicator **54** may also be built into the vehicle **12**. Those skilled in the art might devise many locations which may be suitable for such installation, and the present invention as claimed should include any particular location. In one embodiment, the legal compliance indicator **54** is mounted adjacent the third brake light

10 **14**. Alternative locations for the legal compliance indicator **54** include but are not limited to the bumper, the trunk, the brake light, or any other suitable surface, either inside or outside of the vehicle **12**.

As shown in Fig. 5, a law enforcement vehicle **84** responds to the legal compliance indicator
15 **54** when the officer sees the first and second red/green LEDs **90** and **92** (or other lights described above) illuminated red, or flashing red. The officer is able to access the central computer **20** to download information from the vehicle database **22** to assist in dealing with the noncompliance of the vehicle **12**. For example, the dispatcher (now shown) for the officer could access the computer network **38** using techniques well known in the art and tell
20 the police, over the existing communications network the status of the vehicle **12**. In alternative embodiments, the police could use an advanced wireless communication device (not shown) to access information directly.

In use, when the vehicle 12 is legally compliant the microprocessor 58 would initially direct the status indicator 64 to show that the vehicle 12 is legally compliant. In the embodiment shown in Figs. 2A-2D, this is accomplished by illuminating both the first and second red/green LEDs 90 and 92 in the green mode. In the embodiment shown in Fig. 3A, only the green LED 68 is illuminated, and the red LED 70. The status indicator 64 will remain in this mode until there is a change in the status of the central computer 20.

As soon as there is a change in any of the external computers 40, such as the law enforcement computer 42, the insurance company computer 44, or the DMV computer 46, the change is reported to the central computer 20 via the computer network 38 and stored in the vehicle database 22. For example, if the DMV computer 46 were to show that the registration of the vehicle 12 was about to expire, this information would be forwarded to the central computer 20, which would update the vehicle database 22 to change the DMV status 30 from registered to due to expire in 30 days. The central computer 20 would then encode this information with the unique vehicle identifier 24 of the vehicle 12, and transmit this information to the legal compliance indicator 54.

When the legal compliance indicator 54 received the signal with the vehicle transmitter/receiver 56, and decoded the message with the decoder 59, the microprocessor 58 would then recognize the unique vehicle identifier 24 and alter the status indicator 64 from "green" to "red" (for example, turning the first and second red/green LEDs 90 and 92 from

green to red). Any passing policeman would be able to immediately recognize that the vehicle 12 is not properly registered and take action, at least to warn the driver to renew the registration. Of course, the data from the external computers 40 would not have to be transmitted directly to the central computer 20, but could be transmitted via lower tech channels and then inputted manually into the central computer 20.

The benefit of the status indicator 64 is that the DMV would no longer have to print and mail registration stickers, and the owner of the vehicle 12 would no longer have to affix the registration stickers to their vehicle 12. It would also no longer be possible to steal registration stickers and use them to fool police into thinking the vehicle 12 was registered. The legal compliance indicator 54 would remain fixed on the vehicle 12, potentially for the life of the vehicle 12, displaying the compliance status of the vehicle 12.

If the vehicle 12 were reported stolen, the signal would cause the legal compliance indicator 54 to flash red, as described above, thereby alerting any nearby law enforcement vehicle 84 (or even other motorists) that the vehicle 12 has been stolen, or was involved in a kidnapping, or other serious crime. The affirmative warning of the flashing red legal compliance indicator 54 would enable many stolen vehicles 12 to be recovered without requiring police to search for specific stolen vehicles 12, but only for vehicles 12 with flashing red lights.

Of course, to enable the legal compliance indicator 54 to function, it would be necessary to prevent tampering with the legal compliance indicator 54. Various anti-tampering devices

and methods are known in the art, and any of these prior art devices or methods may be adapted to the present invention.

The power supply 62 may be the battery of the vehicle 12 directly wired into the legal compliance indicator 54. In an alternative embodiment, the power supply 62 may be provided by a separate battery (not shown) directly attached to the legal compliance indicator 54. The separate battery would preferably be securely stored within the legal compliance indicator 54 to prevent tampering. In yet another embodiment, the legal compliance indicator 54 further includes a solar cell (not shown) that can power the legal compliance indicator 54 as well as recharge the separate battery.

In an alternative embodiment, the power supply 62 is a power storage circuit (not shown) that derives power from the transmission that is received. When the transmission is received, the circuit stores the energy generated by the signal and uses the energy to temporarily power the microprocessor 58 and the status indicator 64. The advantage of this arrangement is that no components would have to be wired to the vehicle 12, thereby facilitating installation, and no batteries would ever have to be replaced. The disadvantage is that the status indicator 64 would have to be queried in order to be activated, rather than being always on and advertising the status of the vehicle 12. Alternative power arrangements can be devised by those skilled in the art, and such alternatives should be considered within the scope of the invention.

As shown in Fig. 6, the invention includes a method for monitoring the compliance status of the vehicle using the vehicle compliance system described above. The status indicator described above is operably controlled by a status indicator control code generated by the central computer.

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The unique vehicle identifier **24** assigned to each vehicle (such as that vehicle's VIN number) is stored in the memory **60** of the legal compliance indicator **54**. The legal compliance indicator **54** is then attached to the vehicle **12** for visually displaying the status indicator **64** described above. Some methods of attachment are described above; however, the invention
10 is not limited thereto, and should also encompass alternative or equivalent attachment method or location. The unique vehicle identifier **24** associated with the vehicle **12** is also stored in the vehicle database **22**.

The compliance status of the vehicle **12** is also stored in the vehicle database. This can be
15 drawn from the external computers **40**, as described above, across the computer network **38**, or it can be manually entered.

When there is a change to the vehicle database **22**, or on a periodic basis, a status indicator control code is created based upon the compliance status. A status indicator signal is then
20 transmitted that includes the unique vehicle identifier **24** and the status indicator control code. Since the generation and transmission of the status indicator signal is within the skill of one skilled in the art, a more detail discussion of the process is not included herein.

The status indicator signal is received at the legal compliance indicator **54** by the vehicle transmitter/receiver **56**, and decoded by the microprocessor **58** / decoder **59**. The unique vehicle identifier **24** contained in the status indicator signal is then compared with the unique vehicle identifier **24** stored in the memory **60** of the legal compliance indicator **56**, and if there is a match, the status indicator control code is used to operably control the status indicator **64**.

With reference to the first embodiment, shown in Figs. 2A-2D, wherein the status indicator **64** includes a first red/green LED **90** and a second red/green LED **92**, the status indicator control code operates as follows: when the compliance status of the vehicle is compliant, both the first and second red/green LEDs **90** and **92** are green (as shown in Fig. 2A); when the compliance status of the vehicle is partially-compliant (for example, if the registration is about to expire), the first red/green LED is green **90** and the second red/green LED **92** is red (as shown in Fig. 2B); when the compliance status of the vehicle **12** is non-compliant (for example, if the registration has expired), both the first and second red/green LEDs **90** and **92** are red (as shown in Fig. 2C); and when the compliance status of the vehicle **12** is stolen, both the first and second red/green LEDs **90** and **92** are flashing red (as shown in Fig. 2D). The first and second red/green LEDs **90** and **92** may also flash red when the vehicle **12** has been reported in an accident, used in a kidnapping, or any other serious infractions, legal violations, or safety issues. This system may also be used to track the driver of the vehicle – for instance, if the driver has an outstanding warrant for his/her arrest.

Similarly, when the status indicator includes a green LED 68 and a red LED 70, as shown in Fig. 3A, the status indicator control code operates as follows: when the compliance status of the vehicle 12 is compliant, the green LED 68 is illuminated and the red LED 70 is not illuminated; and when the compliance status of the vehicle 12 is non-compliant, the red LED 70 is illuminated and the green LED 68 is not illuminated. The red LED 70 may also flash, as described above, when the compliance status is stolen (a term including all of the other circumstances described above).

As shown in Fig. 1, the vehicle legal compliance system 10 may also include a GPS 65 (global positioning system) for the purposes of monitoring the location of the vehicle 12. The inclusion of the GPS 65 enables the police to readily locate the vehicle 12 in the event that the vehicle database 22 shows a serious infraction. For example, if the vehicle 12 is reported stolen, or is used in a crime, not only would the status indicator 64 begin to flash red, but the police would also be able to receive directions that would lead them directly to the vehicle 12. It is important that the GPS 65 is not activated until the central computer 20 receives a report that a serious infraction or crime has been committed. It is up to the police or other authorized agency to determine what infractions or crimes are serious enough to warrant the activation of the GPS 65. Otherwise, the GPS 65 could not be activated, thereby protecting the privacy of the driver of the vehicle 12.

While the preferred embodiments of the present invention have been described, those skilled in the art can devise alternative arrangements and structures that are equivalent to the described invention, and these alternative embodiments should be considered within the scope of the present invention.